IDENTIFYING REVERSE EXCHANGE PRACTICES: A COMPARATIVE STUDY OF LAUNDRY LOGISTICS IN PUBLIC HOSPITALS (THAILAND).

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Abstract

Purpose

The effective reverse exchange of healthcare products such as laundry within a hospital environment can support the health system, for achieving the highest goal: **'to provide regular and timely supply of clean linen to the satisfaction of patients and staff'** (Srikar et al., 2015, p. 593). Previous studies by Bandoophanit et al. (2015, 2017) assert there are constant shortages of linen availability in many Thai public hospitals which can undermine the efficacy of laundry management and quality of medical treatment. This study investigates the practices, culture, and operational performance of three large-sized public hospitals (700-2,000 beds) located in Thailand reflecting on the application of Reverse Exchanges (R/E) theory. This study contributes to the Thai healthcare agenda, a core mission of which is to *"Develop the health system with quality, efficiency and equality; with participation of the people, communities and all sectors for good health of all Thai people in order to achieve a good and sustainable society following the King's Sufficiency Economy philosophy"* (Ministry of Public Health, 2018).

Research Approach

A qualitative comparative approach was adopted when investigating RE practices within each of the participating hospitals. Key criteria for selecting case hospitals were based upon accessibility and sites with hospital accreditation (HA) for environmental performance. The hospital visits were undertaken during February and March 2018. Data was collected via in-depth interviews, observations, content and cross-case analysis methods. The analysis led to the development of indicators which could identify effective R/E practices based on key logistics measures such as sufficiency of linen (par/set), speed, and quality of service.

Findings and Originality

This study demonstrated that linen shortages are commonplace across all hospital sites. Key causes include (i) slow procurement processes and transparency, (ii) the imbalance between increasing volume of patients and the amount of budget allocated for linen, personnel and machinery (iii) equipment failure caused by ineffective product sorting and loading and (iv) procurement freezes. Other options such as outsourcing of laundry operations were not considered viable due to the quality of the service provided by 3rd party providers.

Research Impacts

Very few studies have uncovered the laundry logistics systems of large-sized hospital sites or examined their effectiveness and efficiency. This study attempts to fill these gaps. Reverse Exchanges (RE), a new theoretical framework, was adopted and supported by the Value Chain and 4 M theories to examine the laundry processes and human factors identified in this study. While hospitals with the

highest HA accreditation should provide the greatest standards of laundry service, the results indicated that they struggled to achieve this goal.

Practical Impacts

Improvement measures have been identified which directly impact on the effectiveness and efficiency of laundry logistics as identified across a multi-site case study. These findings can influence government healthcare policy design, hospital procurement strategies, job design and management of hospital laundry operations in Thailand.

Keywords: Reverse Exchange, Practice Identification, Laundry Logistics, Thailand's Public Hospitals

Healthcare Laundry Management

Linen is a general term for clothing items, including blankets, bed sheets, blue sheets, patients' clothes, gowns and towels (Gajuryal, 2014). The management of used hospital linen differs from other large institutions because they are contaminated with blood excreta or secretions and others have been used for infected patients (Barrie, 1994). Various studies found that poor-cleaning linen can pose as a vehicle for the transfer of pathogens to patients or hospital workers; which can contribute to the spread of nosocomial infections (e.g. Fijan and Turk, 2012). The transmission of diseases can prolong the patient's stay in the hospital or even, in extreme cases, paralyze the carrying out of surgical operations (García Fernández et al., 2001). Therefore, effective healthcare linen management is very important for all healthcare settings. Laundry management aims at providing sufficient clean linen to all users, with the qualified standards of cleanliness and timeliness (NHS, 2015), and complying with particular Guidelines of National Health Service Infection Control (IC). Linen management is either responsible by the Laundry Department (inhouse) or outsourced to external providers. This can sometimes lead to the perception of depleted quality standards incresasing the potential of infection and contamination (Toffolutti et al. (2017). On reviewing extant literature on linen/textile management in healthcare we can see that the most salient discussions have focused on (i) controlling the spread of infections/antimicrobial textiles (e.g. Anand et al., 2010, Cheng et al., 2015), (ii) the observations of microencapsulation of herbal extracts for microbial resistance in textiles (Thilagavathi and Bala, 2007, Hui et al., 2013) and (iii) the development of smart healthcare textile and hygiene products (Stoppa and Chiolerio, 2014). Improvements laundry operations honed in on the following areas (i) investing in new machinery, (ii) cost optimization, (iii) adopting new cleaning strategies, and (iv) using in-house facilities vs outsourcing this service.

Reverse Exchange Theory: For Healthcare Reusable Products

Reverse Exchange (RE) is an immature area of logistics study, but is grounded in more traditional theories particularly Reverse Logistics (RL). The RL concept focuses the movement of products or materials in the opposite direction for the purpose of creating or recapturing value, or for proper disposal (Rogers and Tibben-Lembke, 2001). Unlike RL, RE relies on product exchanges (those which are used as part of a service process for a given period of time, so 'on loan to someone for a specific purpose' but will have to be exchanged within a given period of time or when they are no longer needed) (Bandoophanit et al., 2017). The concept and application of RE has been examined in a number of different sectors and operational foci: medical device exchanges (Xie et al., 2016); service supply chains (Kumar et al., 2016); and customer motivation (Yuan et al., 2016, Bandoophanit et al., 2017). In the service industries, RE takes an insight into the exchange of single-used products between specific stakeholders e.g. customer, distributor and manufacturer. Therefore the exchange has a clear movement and low repetition of exchange (Kumar et al., 2016). This is very similar to several healthcare products such as single-used medical devices – infusion pumps (Xie et al., 2016).

However this has never been applied to products such as bed linen that requires the daily exchanges to maintain service continuity.

Within the hospital operation there are several multiple-use products such as linen, metal medical devices, food containers that have to be exchanged multiple times within their life cycle and if they are not available services can be delayed or halted. These exchanges are generally occurring through their lifetime, returning to non-specific customers, and mostly within the hospital (Hootajuta and Poonnakitikasem, 2010, Smith et al., 2011). Unlike other service industries, the expectation of healthcare customers is much greater concerning hygiene and safety; which increases the importance to explore and apply the use of RE in this area. As reported by Bandoophanit et al. (2017) there is a dearth of research studies and publications which focus on laundry operations as a closed-loop service. The authors state that *"To all intents and purposes this system, purpose, design and execution sits firmly within a number of supply chain camps, relating to Supply Chain Management (SCM), Reverse Logistics (RL), Closed-Loop Logistics (CLL) and Reverse Exchanges (RE)"* (Bandoophanit et al., 2017, p. 2). As shown in other studies (e.g. Xie et al., 2016) the concept of RE is being more widely explored and adopted but there are currently no known RE laundry management studies available.

Laundry Logistics in Thailand's Healthcare Settings

By law, Thailand Ministry of Public Health (MOPH) is responsible in governing and controlling all public hospitals including the compliance of new legislation, the amounts of budget allocated, labour employed and organizational structure (NHSO, 2013, Ministry of Public Health, 2018). The infection control regulation (2013) aims to prevent or stop the spread of infections in healthcare settings. This includes the guidelines for laundry such as (i) staff must wear proper protections, (ii) used linen must be sorted and bagged before carrying to the laundry, and (iii) infected linen must be washed in high-temperature water etc. As reported by Bandoophanit et al (2017) when applying RE to a laundry management service, the focus is on a group of products which include bed linen, towels and gowns/pyjamas for patient/ward use. These items are used by the patient for a given duration and then returned to be cleaned at the laundry and reallocated. R/E in this industry is more person/patient centric and innately responds to patient demand for the service and bed capacity. These items are all single use so the turnover is very high and can be more than once a day. From an operational and economic perspective the focus in laundry operations is both 1) the availability of the product - how can it be recovered, cleaned and returned for further use in a controlled and timely fashion but also 2) the durability of the product - how can we maintain/extend the product's lifecycle to get maximum utilisation and value from it. Previous studies found the causes of linen shortages uncovered included having lower stock volume than standards (less than 4-6 sets), ineffective cleaning activities/management, poor linen exchange system, inappropriate duty, segregation broken machines, insufficient personnel, weak procurement practices and over-stocking on hospital wards (e.g. Bandoophanit et al., 2017)

A limited number of studies have applied reverse exchange concept to deeply explore and compare the laundry management of several hospitals for better understanding a wide range of operational efficiency/inefficiency, root causes and effective solutions. In order to examine and propose recommendations for improvement within the reverse exchange of laundry logistics systems, these elements and others will be explored in this study.

Research Methodology

Key methods used to investigate RE practices as applied to laundry logistics in these hospitals were interviews, observations and documentations for data collection (Johl and Renganathan, 2010). The study adopted a 'purposeful sampling strategy' method, selecting three case hospitals to collate information-rich cases related to the phenomenon of interest (Palinkas et al., 2015). Due to having limited time and budget, the selection criterion used to select the sites were: 1) being the best practices in laundry management; 2) accessibility of data and 3) short transportation to case hospital. Therefore, three case hospital were contacted called "B" (2,000 beds), "C" (867 beds) and "D" (826 beds) located in different province. The hospital visits were undertaken during February and March 2018. These areas were observed: laundry management processes (particularly the linen exchanges), and standards; personnel perception and understanding of these processes; statistical data, failure identification, root cause analysis and problem resolution data associated with this operation. A large volume of collected data was reviewed and managed by "content analysis". This was then further analyses using **'The 4-M Checklist'**. This tool allowed the researcher to analyses contributing factors (man, machine, methods, and materials) which led to the development of performance indicators (Bringslimark, 2006). Therefore, after observing linen management processes (**M-M**ethod), key research indicators can be developed including (i) sufficiency of linen (par/set) (**M-M**aterials), (ii) a volume of machines (**M-M**achines), (iii) a number of personnel (**M-M**an), (iv) speed (hour/day) (**M-M**ethods) and quality of service (**M-M**ethods). Through this process, when comparing degrees of achieving the objectives across cases, the similarities and differences can be noticed (Miles and Huberman, 1994, pp., p.190).

Research Findings

1) Hospital Background

In order to fully understand the concept of reverse exchanges in Thai Hospitals observational analaysis was undertaken in the case study sites. There were three case hospitals (see Table 1) referred to in this study as Hospitals "B", "C" and "D".

Table 1: Overview of Hospitals within the study.

Background	Hospital "B"	Hospital "C"	Hospital "D"
1.1 Bed-size	2,000 beds	867 beds	826 beds
1.2 Type	University Hospital	Central Hospital	Central Hospital
1.3 HA level	HA3, now moving to CQI	HA3	HA3, now moving to CQI
1.4 Volume of used linen	9,000 – 10,000 kg/day	7,500 – 8,000 kg/day	4,500 – 5,000 kg/day
1.5 Laundry Management	In-house	In-house 2,500 kg (infected linen), and Outsourced 5,500 kg (general linen)	In-house
1.6 User	78 Large Departments (key users: ICU followed by Surgery wards and operation theatres)	40-50 Departments (key users: ICU)	73 Departments (key users: Medicine ward, and Surgery ward)
1.7 Volume of staff	1 Head and 67 workers	1 Head and 42 workers	1 Head and 42 workers

Source: Hospital "B", "C" and "D".

2) Summary of Findings

Using data collected from the various data collection tools, the following profile was constructed of hospital site laundry logistics based on the Value Chain theory (see Table 2). Some similarities and differences were clearly presented. Their similarities include cleaning time per cycle (4-5 hours), following standards of linen management processes, and management of old/torn linen. The differences identified were particularly stock levels ("B"-3 sets, "C"- not sure, and "D" – about 1 set), budget spent on linen ("B" 15-18 million Baht in 2016 but no budget spent during 2017, "C" 21-22 million Baht per year, and "D" 1 million Baht in 2017).

Table 2: Observation Results on Linen Management.

Reviewed criterion	Hospital "B"	Hospital "C"	Hospital "D"
2.1 Purchase of linen	Head: annually for 15-18 million baht Staff: "B" did not purchase* last year	Sub Head: the purchase is 21-22 million baht per year.	Head: annually for 1 million baht
2.2 Set of linen ***(Linen Shortage)***	-Patient cloth = 4 sets - Low usage linen = 2 sets *So average = 3 sets	- Do not ensure about this because linen was lost very often	- Now has only 1 or less-than-1 set. Last two years usually has 3-4 sets
2.3 Linen lifetime	General linen- 3 years Operation linen – 2 years	N/A	1 year or less
2.4 Time per cleaning cycle	4-5 hours up to a day	Inhouse = 4-5 hours Outsource = 6 hours/more	4-5 hours
2.5 Control of torn linen	-Type the year of purchasing on linen -Torn linen is fixed/repaired	-Torn linen is fixed/repaired	-Type the year of purchasing on linen -Torn linen is fixed/repaired
2.6 Washer/ Dryer	50% of the washers were not functioning for more than 6 months	Broken issue was caused by programme error for some machines	2 from 5 washers are not functioning due to a programme error for more than 3 months
2.7 Linen segregation	Untie bed knot, various medical objects and human waste are sent to washer.	Small objects are rarely found with linen.	A bag of surgical waste (e.g. wastage blood), forceps, scissors, needle syringe, blades and bed pans are found every day amongst linen bundles.

Source: Hospital "B", "C" and "D".
*currency conversion 1 USD = 33 Baht, and 1 GBP = 43 Baht.

Data Analyses and Discussions

The observations and analyses of data from Table 1 and Table 2 provided evidence of factors which negatively impact on the availability of linens in Thai hospitals. These are analysed further below using Value Chain and 4M frameworks supported by RE theory.

1. **Man - Personnel:** Personnel at "B" had the largest laundry operation with 9,000 – 10,000 kg of linen per day and 67 staff. Each staff member had to manage 134.33 – 149.26 kg of linen. The US guidelines state that a one staff member should manage 60-75 kg of linen, or 15 personnel for 200-

300 bed (including managers) (Gajuryal, 2014). According to this, "B" should have more than 150 staff for 10 tons of linen; therefore, more than 80 staff (1.5 time) should be recruited to support the high-workload activities. The heavy-workload activities of luandry are washing-drying linen, and folding linen; which found having insufficient staff. Besides, staff of these activities have to work from 07.00 to 22.00 daily and has only 2-4 day-off per month. Interestingly, the Head of Laundry decided to recruit 7 additional staff to transport linen twice a day (7.30 – 9.00 and 15.00 – 16.30). This activity was mainly supported by a nurse aid or maid from wards who have more free-time than laundry staff. "D" also requires more staff of at least 40 persons. Clearly, only "C" has provided appropriate workload for their staff (59.52 kg of linen per day). When asked why some hospitals have insufficient staff, "C" said that, *"It is mostly decided by the Director about how the budget is allocated. If they realize the importance of laundry, they can allocate more budget like our hospital."* Most interviewees felt that they had very high workload and reported this issue several times and asked for more staff. Previous studies indicate that clear guidance provided by the Ministry of Public Health (MOPH) should be given to all public hospitals and all hospital departments to support Healthy Workplace Framework (Department of Health, 2018). A more serious monitoring and action taken on budget allocation, and the real workload versuss job description, as part of HA should be considered and provided (Barrie, 1994, NHS, 2015).

2. Budget and Linen: From Table 2, "C" appears to have appropriate working levels of linen stock. However it was reported that the wards of "C" have poorer control on linen usage, which staff, patients and relatives can pick more linen than needed which contributed to regular linen shortages. "B" and "D" reported that they have suffered greater linen shortages. Observations on several wards of "B" found that they had a larger safety stock than they need; with some wards refusing to reduce their stock levels. In comparision "D", had only 1 or less sets of linen, which is much lower than the standard expectation. It means that linen used each day must be collected, cleaned and delivered back to be used for the night cycle. Since there is no linen safety stock maids on wards provide better control of using and disposing/sorting wastage linen from wards, as well as transporting linen to and from laundry by themselves. The extensive pressure from users dictated that the laundry services of "D" had the fastest cleaning time - 4-5 hours per cycle. From our study, it can be concluded that an common cause of linen shortages was a limited purchasing budget. The average budgets for purchasing linen annually were (i) "C" - 21-22 million Baht per year, (ii) "B" - 15-18 million Baht, and (iii) "D" – 1 million Baht (after having new Director). Other factors compounding linen shortages was the transfer of budget dedicated to linen procurement/replenishment to a hospital extension ("D"); new machinery ("B"); loss of stock due to patients leaving the hospital or dying ("B", "C" and "D"); weak outsourcing contract and performance ("C"); lack of support from senior management ("D"). The results indicated that the management and control of laundry logistics and the efficient turnover, exchange of stock relies heavily on many parties within the hospital operation. This concurs with the view that the administration and the laundry personnel have responsibility to provide better control/monitoring, and take action/make a decision when managing contracts e.g. outsourcing (Arisi-Nwugballa, 2016, Toffolutti et al., 2017). Leadership awareness is the key driver for successful adoption of new strategy to support the implementation of reverse exchange practices (Thiell et al., 2011, Xie et al., 2016).

3. Machine and Management: Other causes of linen shortage are due to (i) malfunctioning machines and (ii) poor waste segregation. 4 out of 8 washing machines at "B" Hospital were broken since the motors were blocked by small medical tools such as forceps, scissors, needle syringe and blades. The waiting time for these to be fixed and operational was more than 6 months. Similarly, "D" has 5 large-sized washers, and 2 were broken because of a program error with a similar lengthy repair time. Reparing machines can take longer time than expected because (i) it needs to purchase new parts, (ii) vendor's technicians are busy (sometime takes more than 6 months), (iii) hospital has too old machines to be fixed, and (iv) 4 new machines (3-4 years life) have poor quality that requires more frequent fixing. The Thai government dictates that certain processes need to be followed when

requesting such products to be repaired. This lenghty process itself causes delays. The management of linen and the ineffective segregation practice has led to staff experiencing needle stick and sharp injures, as well as having to consent to blood tests to check for infections which can be time consuming so workers may be denied this opportunity (Sharma et al., 2010). According to waste management guidelines of the World Health Organisation (1999, 2011), these tools should be sorted at sources such as clinics and wards to be further sterilised, or disposed off, and not cause such risks in the laundry operations. Also, linen should be sorted from sources mainly into (i) infected linen and (ii) general linen, because they use different cleaning procedures, failure to do so carries risk but also extends the time taken for the laundry cycle.

Conclusion

The aim of the linen management is **'to provide regular and timely supply of clean linen to the satisfaction of patients and staff',** as mentioned earlier. This study principally applied RE theory, in combination with Value Chain and 4 M theories, in exploring the laundry department of large-sized hospital sites. Too frequent exchanges (R/E) are generally found, mostly in Hospital "D"; delivering excessive hot cleaning per linen set. This highly deteriorates the fabric, reduces linen life time and increases the purchase volume in the following year. To minimize the exchange was undertaken and firstly found hardly achieved, since there is insufficient volume of linen (1-3 sets). It occurs although each site had the highest HA accreditation that specifies having 4-6 sets. Several causes were identified including (i) slow procurement processes and transparency, (ii) the imbalance between increasing volume of patients and the amount of budget allocated for linen, personnel and machinery (iii) equipment failure caused by ineffective product sorting and loading and (iv) procurement freezes. Even if having various limitations, to provide clean linen on time, maids on wards are key persons to control of using and disposing/sorting wastage linen from wards, as well as transporting linen to and from laundry by themselves. Evidently, human factors particularly by the perspective of the Director on budget allocation and the importance of laundry services, is the key driving forces providing insufficiencies of budget, linen, personnel and machine. These findings can influence government healthcare policy design, hospital procurement strategies, job design and management of hospital laundry operations in Thailand.

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